PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Flathead River Instream Flow Project (Mfwp Umbrella Subproposal)

BPA project number: 9502500
Contract renewal date (mm/yyyy): 4/1999 ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Montana Fish, Wildlife & Parks - Subcontract

Business acronym (if appropriate) MFWP

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
10.2A.2, 10.2B, 10.3A.1, 10.3A.2, 10.3A.3, 10.3A.4, 10.3A.6, 10.3A.9, 10.3A.11, 10.3A.18.

FWS/NMFS Biological Opinion Number(s) which this project addresses
Bull Trout Listed as threatened (63 FR 31647)
Westslope cutthroat trout - Petitioned for ESA listing (63 FR 31691)
NMFS Hydrosystem Operations for salmon and steelhead recovery (56 FR 58619; 57 FR 14653; 62 FR 43937)

Other planning document references
Flathead National Forest Plan (Brannon 1985); Monitoring Master Plan for Flathead Basin (Flathead Basin Commission 1995, 1997); Hungry Horse Mitigation Plan (1991); Hungry Horse Implementation Plan (1993); May et al. (1988); Knotek et al. (1997); Montana Bull Trout Restoration Team (1997); Montana Westslope Cutthroat Trout Restoration Plan (MFWP In Prep); Flathead River Drainage Bull Trout Status Report (Montana Bull Trout Scientific Group 1995). Montana Stream Protection Act (1963). Natural Streambed and Land Preservation Act (1975).

Short description
Conduct IFIM study on Flathead River from South Fork confluence to Flathead Lake. Determine effects of flow fluctuations and temperature control on habitat, bed load, predator-prey interactions and migrations. Link river model to reservoir model (HRMOD).

Target species
Natives: Bull trout, westslope cutthroat trout, mountain whitefish, pygmy whitefish. Native predator: Northern pikeminnow. Non-native competator/predators: rainbow trout, northern pike, lake trout.

Section 2. Sorting and evaluation

Subbasin
Upper Columbia - Flathead River main stem.

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☐ Anadromous fish ☒ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☒ Operation & maintenance ☐ New construction ☒ Research & monitoring ☒ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
20554	Hungry Horse Fisheries Mitigation
9401002	Flathead River Native Species Project
9101901	Hungry Horse Fisheries Mitigation - Confederated Salish and Kootenai Tribes
9101903	Hungry Horse Mitigation - Watershed Restoration and Monitoring
9101901	Flathead Lake Monitoring and Habitat Enhancement
9101904	Nonnative Fish Removal / Hatchery Production

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
8346700	Libby Reservoir Mitigation	This project is just finishing an IFIM for the Kootenai River. Results from the Kootenai are applicable to the Flathead.
8346500	Libby and Hungry Horse Modeling Technical Analysis	We were instructed by ISRP, BPA and CBFWA to place this project into umbrella with 8346700 and 9101903. This project funds one computer consultant to combine the quatitative reservoir models HRMOD and LRMOD with the IFIM models developed by this project.
3874700	Streamnet Geographic Information Services Unit	Provide GIS and GPS support. Assist with river mapping data.
9608701	Flathead Focus Watershed	CSKT Cooperator

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1997	Project proposal approved by CBFWA and ISAB for funding in FY98 to initiate 3 year project.	RFP not initiated by BPA, work did not begin as scheduled. Biological aspects began under project 9401002, radio telemetry identified seasonal movements and located primary staging areas in river.
1998	second year approved by CBFWA and ISRP, FY99.	RFP process begun by BPA and is ongoing, contractor not yet selected, work did not begin. Project 9401002 began to analyze correlations between fish locations and environmental factors.
1999	Contractor will be selected through ongoing RFP process. Work to begin spring 1999.	3 year IFIM project will begin. Biological assessments continued as part of subproject 9401002. Objectives for biological aspects met on schedule.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Develop comprehensive spatial and tabular/attribute database (IFIM models) to characterize physical processes in the Flathead River affected by flow from Hungry Horse Dam	a	Compile spatial database (GIS map) of the Flathead River from the South Fork confluence downstream to Flathead Lake
1		b	Integrate smaller scale information on riparian land use and vegetation, macro-habitat classification, thermal modeling results and hydrographic modeling results.
1		c	Integrate detailed channel topography using scanning hydroacoustics and doppler profiling for micro-habitat and sediment transport modeling
2	Use IFIM models to compare the results of alternative dam operational strategies on aquatic resources	a	Develop an array of potential scenarios for managing river flows to meet biological objectives
2		b	Determine cost-effective operation to minimize predation of juvenile bull trout and westslope cutthroat trout by lake trout and northern squawfish
2		c	Determine the magnitude, timing and duration of the peak flow event needed to move fine sediments to enhance aquatic production
2		d	Establish flow ramping rates to minimize riparian vegetation loss due to bank failure and lateral migration

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	4/1999	12/2001	Complete abiotic framework for overlay of biological information	Calibrated flow, water temperature and tractive forces	100.00%

				longitudinal model	
2	1/2001	3/2003	Use calibrated model to establish science-based seasonal flows and ramping rates	Submit recommendations to operating agencies for implementation	0.00%
				Total	100.00%

Schedule constraints
Initiation and execution of the RFP process has delayed the start of this project. Fortunately, recent advancements in foreward scanning hydroacoustics, doppler profiling and computing will strengthen this project. The RFP process is nearly finished.

Completion date
03/2003

Section 5. Budget

FY99 project budget (BPA obligated): $100,000

FY2000 budget by line item

Item	**Note**	**% of total**	**FY2000**
Personnel			
Fringe benefits			
Supplies, materials, non-expendable property			
Operations & maintenance			
Capital acquisitions or improvements (e.g. land, buildings, major equip.)			
NEPA costs			
Construction-related support			
PIT tags	# of tags:		
Travel			
Indirect costs			
Subcontractor	Project will be 100 percent subcontracted by BPA	%100	100,000
Other			

TOTAL BPA FY2000 BUDGET REQUEST	$100,000

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
MFWP	Biological data: fish locations and microhabitats, insect densities related to substrate types	%54	120,000
USFS	Provide high resolution aerial photographs for digital mapping		0
Total project cost (including BPA portion)			$220,000

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$ 0	$ 0	$ 0	$ 0

Section 6. References

Watershed?	Reference
☒	Appert, S. and P. Graham. 1982. The impact of Hungry Horse Dam on the aquatic invertebrates of the Flathead River. Final report of the Montana Dept. of Fish, Wildlife and Parks, Kalispell, Montana, to the U.S. Bureau of Reclamation. 90 pp.
☐	Bovee, K.D. 1978. Probability-of-use criteria for the family Salmonidae. Instream Flow Information Paper 4. United States Fish and Wildlife Service FWS/OBS-78/07. 79pp.
☐	Bovee, K.D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Information Paper 12. United States Fish and Wildlife Service FWS/OBS- 82/26. 248pp.
☐	Bovee, K.D. 1986. Development and evaluation of habitat suitability criteria for use in the Instream Flow Incremental Methodology. In-stream Flow Information Paper 21. United States Fish and Wildlife Service, Biological Report 86(7). 235pp.
☐	Bovee, K.D., and R.T. Milhous. 1978. Hydraulic simulation in instream flow studies: theory and techniques. Instream Flow Information Paper 5. United States Fish and Wildlife Service FWS/OBS-78/33. 129pp.

☒	Brannon, E.B. 1985. Forest Plan: Flathead National Forest. United States Forest Service, Kalispell, Montana.
☐	Christenson, D.J., R.L. Sund and B.L. Marotz. 1996. Hungry Horse Dam's successful selective withdrawal system. Hydro Review / May 1996:10-15.
☐	Cushman, R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management. 5:330-339.
☐	Dalbey, S.R., J. DeShazer, L. Garrow, G. Hoffman, and T. Ostrowski. 1998. Quantification of Libby Reservoir levels needed to enhance reservoir fisheries. Methods and data summary, 1988-1996. MFWP, for BPA. Project 83-467.
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☒	Flathead Basin Commission. 1997. Biennial report: 1995-96. Kalispell, Montana.
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☐	Fraley, J., S. McMullin, and P. Graham. 1986. Effects of hydroelectric operations on the kokanee population in the Flathead River system, Montana. North Am. Journal of Fish. Management 6:560:568.
☐	Fraley, J. and J. Decker-Hess. 1987. Effects of stream and lake regulation on reproductive success of kokanee salmon in the Flathead system, Montana. Regulated Rivers, Vol. I. pp.257-265.
☒	Fraley, J., B. Marotz, J. Decker-Hess, W. Beattie, and R. Zubik. 1989. Mitigation, compensation, and future protection for fish populations by hydropower development in the upper Columbia System, Montana, USA Regulated Rivers: Research & Management 3:3-18
☐	Hall, C., J. Jourdonnais and J. Stanford. 1989. Assessing the impacts of stream regulation in the Flathead River Basin, Montana, USA I. Simulation modeling of system water balance. Regulated Rivers 3:61-77.
☐	Hauer, F.R., J.T. Gangemi and J.A. Stanford. 1994. Long-term influence of Hungry horse Dam operation on the ecology of macrozoobenthos of the Flathead River. Prepared for Montana Fish, Wildlife and Parks, Special Projects Bureau, Kalispell, Montana.
☐	ISAB. 1997. The Normative River. Independent Scientific Advisory Board report to the Northwest Power Planning Council and National Marine Fisheries Service. Portland, OR.
☐	ISAB. 1997b. Ecological impacts of the flow provisions of the Biological Opinion for endangered Snake River salmon on resident fishes in the Hungry Horse, and Libby systems in Montana, Idaho, and British Columbia. Report 97-3.
☐	ISG. 1996. Prepublication Copy. Return to the River: Restoration of salmonid fishes in the Columbia River ecosystem. Development of an alternative conceptual foundation and review and synthesis of science

	underlying the FWP. Document 96-6.
☒	Knotek, W.L., M. Deleray, and B. Marotz. 1997. Fish passage and habitat improvement in the upper Flathead River basin. Montana Fish, Wildlife, and Parks, Kalispell, Montana. Prepared for Bonneville Power Administration. 60 pp.
☐	Marotz, B.L., C.L. Althen, and D. Gustafson. 1994. Hungry Horse Mitigation: aquatic modeling of the selective withdrawal system - Hungry Horse Dam, Montana. MFWP, for BPA. 36 pp.
☐	Marotz, B.L., D. Gustafson, C.L. Althen, and W. Lonon. 1996. Model development to establish integrated operational rule curves for Hungry Horse and Libby Reservoirs - Montana. Montana Department of Fish, Wildlife, and Parks. Prepared for BPA. 114 pp.
☐	May, B., S. Glutting, T. Weaver, G. Michael, B. Marotz, P. Suek, J. Wachsmuth and C. Weichler. 1988. Quantification of Hungry Horse Reservoir water levels to maintain or enhance reservoir fisheries. MFWP, for BPA. 68 pp.
☒	MFWP, CSKT and KTOI. 1998. Fisheries Mitigation and Implementation Plan for losses attributable to the construction and operation of Libby Dam. Montana Fish, Wildlife & Parks, Confederated Salish and Kootenai Tribes, Kootenai Tribe of Idaho. 50 pp.
☐	Milhous, R.T., M.A. Updike, and D.M. Schneider. 1989. Reference manual for the Physical Habitat Simulation system (PHABSIM) - Version II. Instream Flow Information Paper 26. United States Fish and Wildlife Service Biological Report 89.
☐	Milhous, R.T., D.L. Wegner, and T. Waddle. 1984. User's guide to the Physical Habitat Simulation System (PHABSIM). Instream Flow Information Paper 11. United States Fish and Wildlife Service FWS/OBS-81/43. 320pp.
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☐	Montana Westslope Cutthroat Trout Recovery Team. In preparation. Montana westslope cutthroat trout recovery plan. Prepared for Montana Fish, Wildlife and Parks, Helena, Montana.
☐	Nehring, R.B. 1992. A 12-year study of rainbow trout and brown trout population abundance in the South Platte River, Colorado, and physical habitat (WUA) variability as determined by the IFIM/PHASBSIM models. Paper presented at AFS Western Division M

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☐	Rantz, S.E. 1982. Measurement and computation of streamflow: Volume 1. Measurements of stage and discharge. United States Geological Survey Water Supply Paper 2175. 284pp.
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☐	Rosgen D.L. 1996. Applied fluvial morphology. Wildland Hydrology. Pagosa Springs, CO. Printed Media Companies, Mpls, MN.
☐	Shepard, B. B. and P. J. Graham. 1982. Completion report. Monitoring spawning bed material used by bull trout on the Glacier View District, Flathead National Forest, MFWP, Kalispell, Montana. 37 pp.
☐	Trihey, E.W., and D.L. Wegner. 1981. Field data collection for use with the physical habitat simulation system of the instream flow group. United States Fish and Wildlife Service Draft Report. 151pp.
☒	Weaver, T.M. and J.J. Fraley. 1991. Fisheries habitat and fish populations. Flathead Basin Forest Practices Water Quality and Fisheries Cooperative Program, Flathead Basin Commission, Kalispell, Montana. 47 pp.
☐	Weaver, T.M. and J.J. Fraley. 1993. A method to measure emergence success of westslope cutthroat trout fry from varying substrate compositions in a natural stream channel. North American Journal of Fisheries Management 13:817-822.
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☐	Wesche, T.A. and P.A. Rechard. 1980. A summary of instream flow methods for fisheries and related research needs. Eisenower Consortium Bulletin 9.
☐	Wright, A. 1996. Review of Columbia River operating criteria. Facilitators Report to National Marine Fisheries Service and Bonneville Power Administration. Al Wright Consulting, Portland, OR. 15 pp. (plus 17 pp. appendices)
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PART II - NARRATIVE

Section 7. Abstract

Construction of Hungry Horse Dam on the Flathead River (completed 1952), changed the physical and biological characteristic of the Flathead River downstream. Hypolimnetic releases from the dam artificially cooled the river from 1952 through 1996 when a selective withdrawal structure was installed on the dam, allowing dam operators to control the water temperature in the tailwater. Now that the thermal pollution from Hungry Horse Dam can be mitigated, a primary manageable threat to Flathead main stem health is dam operation. Flow fluctuations from power and flood control operations create an extensive, low productivity, varial zone, greater substrate imbeddedness and species shifts in the aquatic insect community which has become less diverse and less productive. A combination of man-caused factors resulted in the decline in native gamefish species (mountain whitefish, westslope cutthroat and bull trout), and a significant increase in abundance of non-game native species (Columbia River chub or peamouth, northern pikeminnow and introduced rainbow trout and northern pike). Pursuant to measure 10.3A.18 of the FWP, this project will use a modified form of the Instream Flow Incremental Methodology (IFIM) to examine the mechanisms by which dam operation effects the riverine community and their environment, and propose operational guidelines to mitigate negative effects. Results will expand the utility of the existing reservoir model HRMOD, verify and refine the Integrated Rule Curves developed for Hungry Horse Dam and evaluate the effectiveness of selective withrawal. This project will be directly contracted by BPA through competitive bid. BPA's RFP process is nearing completion.

Section 8. Project description

a. Technical and/or scientific background

Hungry Horse Dam (completed in 1952), changed the physical and biological characteristics of the Flathead River downstream (Appert and Graham 1982, Fraley and Decker-Hess 1987, Fraley and Graham 1982, Fraley et al. 1986, Fraley et al. 1989, Hall et al. 1989). Hypolimnetic releases from the dam artificially cooled the river and caused rapid temperature fluctuations from 1952 through 1996. In August 1996, a selective withdrawal structure was installed on the dam, as part of the Hungry Horse Mitigation Program, allowing dam operators to control the water temperature in the tailwater (Marotz et al. 1994; Christenson et al. 1996). Now that the thermal pollution from Hungry Horse Dam can be mitigated, a primary manageable threat to watershed health is flow fluctuation caused by dam operation. Power and flood control operations have essentially reversed the natural hydrograph by storing the spring melt in the reservoir, and then releasing water for power production during the cold months when natural flows would be normally low. Short term flow fluctuations caused by power operations create an extensive, low productivity varial zone, greater substrate imbeddedness and species shifts in the aquatic insect community which has become less diverse and less productive (Hauer et al. 1994). River flows and flow fluctuations also cause important changes in habitat availability and fish movements (Cushman 1985). A combination of man-caused factors resulted in the decline in native gamefish species, mountain whitefish, westslope cutthroat and bull trout, and a significant increase in abundance of non-game native species, the Columbia River chub or peamouth, northern squawfish and introduced rainbow trout.

An annual flow regime with tolerable flow fluctuations is needed to maximize the effectiveness of the selective withdrawal structure and to balance riverine productivity with hydropower production and flood control. Measure 10.3A.18 of the NPPC Fish and Wildlife Program calls for consultations with MFWP and CSKT when conflict occurs between reservoir and river requirements. The goal is to provide information to resolve potential conflict between reservoir and riverine operational requirements, and to restore normative conditions in the Flathead Watershed (ISAB 1997).

Since 1995, recovery actions for anadromous salmon and steelhead, as directed by NMFS (NMFS 1995), have influenced the timing of water released from Hungry Horse Dam. Specifically, summer releases of reservoir storage to augment downstream flows have caused unnatural flow fluctuations in the Flathead River during the productive summer months. Unless we understand the effects of these releases, recovery actions may counter or reverse mitigation efforts to balance the needs of resident and anadromous fish (ISAB 1997b).

This project will use a modified application of Instream Flow Incremental Methodology (IFIM) in four reaches of the Flathead River. Reach 1 begins at the confluence with the South Fork Flathead River and extends downstream 20 miles to a gradient break above the Stillwater River confluence. This reach is mostly homogeneous with some island complexes. At this point the river becomes a braided, depositional area with added inflow from the Stillwater River, designated reach 2. The third reach extends from this braided section to elevation 2893 ft msl., where the river stage becomes influenced by Flathead Lake. The fourth reach, which begins at this point and extends to the mouth, is characterized by seasonal backwater effects from the lake impounded by Kerr Dam. The entire river segment downstream of Hungry Horse Dam will be mapped using GIS and GPS technology and high resolution maps provided by the US Forest Service to document detailed changes over time. Larger scale attributes within the three reaches will be extrapolated from detailed measurements of river morphology, hydrography, sediment typing and habitat parameters. Microhabitat use by fish species and life stage will be compiled by project 9401002 and overlaid on the framework provided by this project. Acceptable flow ramping rates will be established seasonally (due to the presence or absence of critical life stages of resident fish).

To accomplish these goals, the selected contractor will establish IFIM transects for hydraulic measurements in each river reach. The contractor will initiate collection of depth, water velocity profiles, substrate type and proximity to cover at established cross-sectional points at all transects, and compile and proof data sets. Stream mapping and profiling will use GIS technology, digitized from low elevation aerial photography, forward scanning hydroacoustics and Doppler profiling. The project will move from macro to microhabitats during the three-year project.

An existing temperature model of the selective withdrawal device (Marotz et al. 1994) will be calibrated for greater longitudinal resolution using data from five thermographs to mesh with this project's objectives. Longitudinal thermal monitoring is ongoing under project 9101903. The refined thermal model, overlaid on the physical framework model, will be used to recommend operational changes to improve conditions for native trout.

An optimization program to link the river IFIM and the reservoir model HRMOD (Marotz et al. 1996), will draw heavily from modeling nearing completion in the Kootenai system (Hoffman et al. In prep.). Modeling typically uses the simplest mathematical tools to make maximal use of available empirical data. Project design and statistical analyses will be reviewed/edited by the MFWP project liaison and University statistical consultants.

Data will be incorporated in a modified IFIM based river model capable of assessing hydraulic and thermal parameters over the range of flows observed in the study area. The project report will recommend an annual regime of flows and allowable flow fluctuations to balance riverine fish production with hydropower generation and flood control. The former technical analysis project 8346500 (now an objective in project 9101903) will link the river model with the existing reservoir model HRMOD to assess tradeoffs when reservoir and river requirements conflict.

Monitoring of the effectiveness of dam operations resulting from the implementation of IRCs is planned under CBFWA approved, project 9501200 which can not begin until operational changes have been implemented.

b. Rationale and significance to Regional Programs

This project provides the physical framework for assessing physical and biological effects of various river operations in the Flathead System. It is a component of the umbrella Hungry Horse Fisheries Mitigation Program (see umbrella proposal) addressing operational mitigation (Integrated Rule Curve refinement and assessment: measure 10.3A of the FWP). Results will help federal dam operators and fisheries managers balance dam operations for the greatest benefit, by balancing fisheries concerns with power production and flood control. The ability to assess tradeoffs between reservoir and river operations, both locally and systemwide, is especially important now that many Columbia River fish species have been petitioned or proposed for listing, or listed under ESA. Also, previous investments in hydropower mitigation should be protected, with special consideration when changes in system operation are implemented. Changes in dam operation for recovery actions in the lower Columbia have been shown to impact resident fish in the headwaters (ISAB 1997b) and must be balanced to benefit all native fish species. Actions taken, must also be affordable or the public will likely stop the effort. To do this, decision makers must have tools to assess tradeoffs and make wise choices.

Since 1982, we have completed and evaluated basin specific models in the headwaters of the Columbia River in Montana. An IFIM effort similar to this ongoing project will be completed in the Kootenai River during spring of 1999. Results to date have played prominent roles in the Columbia Basin System Operation Review (reservoir screening model and subbasin analyses), Kootenai White Sturgeon Recovery Actions (IRCs and tiered flow approach), Watershed Equity Team (system analyses to balance resident fish needs with anadromous fish recovery), Al Wright Process (1996)(system evaluation to assess IRC and BiOp operations to find common goals and strike a balance between anadromous and resident fish), and periodic systemwide analyses (BPA's HYDROSIM, NPPC's SAM etc.).

This tool is applicable to other storage projects in the Columbia System given the necessary site-specific data. The Independent Scientific Group recommended that our reservoir modeling strategy (IRCs) be applied to other US subbasins containing storage projects (ISG 1996). Past experience has shown us how to speed the data acquisition and modeling process and reduce costs. It is now possible to qualitatively assess the biological effects of operational alternatives (i.e. develop simplified versions of IRCs) based on hydrology alone. Simplified screening models (as were used in the SOR process) can direct research efforts into the most critical areas, thus saving time and money. As a research program matures, empirical data can be incorporated into a quantitative model (similar to HRMOD and LRMOD). Decisions can be made with increasingly greater confidence and resolution as the model becomes more quantitative and incorporates downstream riverine effects.

c. Relationships to other projects

This project extends and complements previous efforts in reservoir and thermal modeling (projects 8346500 and 8346700 in the Flathead and Kootenai drainages). Biological sampling and ongoing mitigation actions (projects 9101903 and 9401002) will provide data for a biological layer in the physical framework constructed by this project. Combined results will provide a tool for future monitoring actions (project 9501200). Thermal monitoring at five stations on the Flathead Mainstem by subproject 9101903 will be used to refine the resolution of the existing thermal model, which then becomes the thermal component attached to the framework.

d. **Project history** (for ongoing projects)

This project was evaluated and approved for funding by the Columbia Basin Fish and Wildlife Authority - Resident Fish Committee for FY98 and FY99. However, the project could not begin until 1999 because of delays in the BPA RFP process. Montana Fish, Wildlife & Parks and the Confederated Salish and Kootenai Tribes wish to have BPA contract this project directly with a qualified contractor. This administrative decision will eliminate overhead and assure that more money will be devoted to on-the-ground actions. A Request For Proposals (RFP) was submitted to BPA to initiate selection of a contractor. The RFP process is nearing completion. The project is planned for a three year term. Associated thermal and biological sampling has been underway since 1987 on separate contracts (projects 9101903 and 9401002).

e. Proposal objectives

1a. Update digitized GIS map of the Flathead River from the South Fork confluence to the mouth on Flathead Lake. The Flathead was previously mapped using aerial photography and digitization. Comparison of the former map with the updated map will identify areas of rapid change. These dynamic areas will be handled separately during data extrapolation and model calibration.

1b. Include land use and vegetative typing of shoreline habitats from aerial photography (classifications include: forage production, grazing, crop production, managed timber, undisturbed timber, cottonwood riparian, specified riparian, rocky, erosive substrates, residential, gravel extraction and public access). Provide dynamic three-dimensional framework on which to overlay the longitudinal thermal model. The thermal model already exists. Thermal profiling as related to discharge and river stage will be overlaid on the hydraulic model. Longitudinal thermal mapping will incorporate data from five continually recording thermographs in the mainstrem and inflowing Stillwater River (by project 9101903). The increased resolution of the thermal model overlaid on the hydraulic framework will increase the utility of both models.

1c. River flows will be calculated at points downstream from the Hungry Horse Dam. Hydraulic calculations representing the main stem Flathead River will quantify the combined discharge at the confluence with the South Fork and Stillwater Rivers. Within each of three river reaches, calibrate IFIM submodels (forward scanning hydroacoustics and Doppler profiling) to describe hydraulic conditions under various flow volumes. Simulate changes in physical habitat conditions at flows of interest. This methodology assumes that habitat conditions within a reach are mainly homogenous so that detailed measurements in one portion of the reach can be extrapolated to the whole. Foreward scanning hydroacoustics will provide three-dimensional maps of the wetted channel. Microhabitat types from transects will be extrapolated to smaller-scaled channel attributes, stratified on depth, substrate type and degree of channel stability. Doppler profiling will provide velocity profiles in macro and micro-habitats as related to discharge and river stage. Sheer stress profiles calculated from water velocity data will provide information on particle size mobility and sediment transport

2a. Use the river model to assess seasonal operational strategies. Once calibrated, the river model will allow the user to simulate varying operational strategies (hydraulic and thermal) and compare the resulting influence on physical attributes. Biological data supplied by project 9101903 overlaid on the physical framework will allow the user to compare the relative affect of varying operational strategies and design operational guidelines to minimizes biological impacts. Seasonal flow minimums and maximums and flow ramping rates in the river will be compared with resulting reservoir operations (using HRMOD) to design an array of potential scenarios for managing Hungry Horse Dam. Recommended seasonal discharge schedules and ramping rates will improve biological production while maintaining a balance with reservoir operations for power production and flood control. Recommendations will consider Hungry Horse Dam operations in the context of the Columbia System, a watershed. This involves multiple model runs across the range of expected (hydrologically possible) conditions, as influenced by downstream dam operations (e.g. Kerr, Noxon, Cabinet Gorge, Albeni Falls etc.). Evaluate results to establish an acceptable range of seasonal operations.

2b. Relate biological functions to thermal, hydrographic and physical attributes. This component is considered the most difficult relationship to develop for large rivers. Given our experience applying this technique to the Kootenai River system, we acknowledge this difficulty and have taken steps to minimize modeling bias. We must assume apriori that the models can be calibrated to actual conditions in the field, so that simulations mimic real physical relationships. Empirical measurements of biological attributes are typically noisy, so mathematical relationships must be based on the best fit between the dependent and independent variables. This can typically be demonstrated graphically, within each model component, so that unrealistic results can be identified and corrected . Where results are counter-intuitive, additional samples can be collected to validate (or disprove) previously established relationships. Selection of a qualified contractor and continuing oversight by the MFWP liaisons during the data collection and analysis process are critical to the success of this project.

Operational scenarios will be provided to the NPPC to assess the relative costs of the array of operations. As was accomplished during the development of the IRCs, economic assessments may lead to minor changes in proposed operating strategies that reduce impacts on power and flood control, yet maintain the desired biological conditions. Many model simulations are required during this phase of the project. We anticipate that model iterations will continue by MFWP and CSKT personnel after this IFIM project is complete.

2c. Model information and field research on water velocity profiles, sheer stresses and sediment types will provide a gross assessment of sediment transport under varying disharge and river stage. Flathead Lake influences the water velocity - stage relationship in the lower 22 miles of the Flathead River, so must be modeled on detailed profile measurements of discharge, velocity and stage. We anticipate that winter releases for power production will have a greater influence on sediment transport in the lower river (when Flathead Lake is low) than the spring freshet which occurs when Flathead Lake is full.

2e. Flow ramping rates will be examined using model simulations comparing the relative influence of operating scenarios on the varial zone. Seasonal effects will be related to insect standing stocks and stranding (from past research and sampling conducted by project 9101903). The final duty of the contractor will be to document modeling methodology, analytical results, recommendations and user instructions in a detailed final report compiled by the contractor. Associated detailed biological assessments will be reported under the umbrella project.

f. Methods

1. Digitized GIS map: low elevation aerial photographs, compiled by the US Forest Service at 3 m resolution, of the Flathead River from the South Fork confluence to the mouth on Flathead Lake will be digitized. A layer will include land use and vegetative typing of shoreline habitats. A comparative overlay with a previous GIS map will be used to identify areas of rapid change. Dynamic areas must be distinguished from stable areas when detailed attributes are extrapolated to larger areas within each reach (see below).

2. Overlay topographical attributes: River gradient will be measured using standard surveying techniques (laser transit and GPS station). Channel morphology will be measured in established transects and longitudinally using forward scanning hydroacoustics (Bovee 1982; Bovee and Milhous 1978; Milhous et al. 1989, 1984; Payne 1992; Rantz 1982). Substrate forms / cover will be measured at transects using SCUBA and sediment scoring techniques. The selected contractor will be allowed to specify and defend the details of specialized modifications.

River flows will be calculated at points downstream from the Hungry Horse Dam. Hydraulic calculations representing the main stem Flathead River will quantify the combined discharge at the confluence with the South Fork and Stillwater Rivers. Hungry Horse operations are recorded daily by the US Bureau of Reclamation. Flow measurements from the US Geological Survey allow for “real data” simulations using historical records, or hypothetical operations can be generated using regression relationships of simultaneously recorded flow data at various points along the river.

3. Calibrate IFIM submodels, simulate changes in physical habitat conditions at flows of interest: This methodology assumes that micro-habitat conditions within a reach are mainly homogenous so that detailed measurements in one portion of the reach can be extrapolated to the whole. This can be accomplished by stratifying the reach by depth, channel form (e.g. single channel, island complex), profile / width and substrate classification so that larger-scaled measurements are used to describe attributes within small-scale categories.

4. Framework on which to overlay the longitudinal thermal model. The thermal model already exists (Marotz et al. 1994). Ongoing monitoring using an array of thermographs will increase the resolution of the model when overlaid on the hydraulic framework, thus increasing the utility of both models. Five thermograph stations were placed in the Flathead River main stem to correspond with reach breaks in this IFIM project. The physical framework is described in items 1-3.

5. Relate biological functions to physical attributes: Project 9401002 is using radio telemetry and directional ground stations to track seasonal movements and staging locations in the Flathead River. Micro-habitats in areas where fish congregate will be sampled in detail (e.g. nose velocity, substrate, depth, proximity to cover, water temperature and gradient) for modeling. Empirical measurements of biological attributes (e.g. insect densities by substrate type) are typically highly variable. Initial samples will be rapidly processed to determine how many samples are necessary to describe each variable.

Without preliminary samples, it is impossible to estimate the degree of resolution necessary to provide meaningful modeling results. However, we anticipate that biological organisms will be related to depth, velocity, substrate type, water temperature and proximity to cover (Read et al. 1982; Shepard and Graham 1982; Weaver and Fraley 1991; Weaver and Fraley 1993; Weaver et al. 1983). Descriptions of microhabitat use have already been developed in the Kootenai for many species (or life cycle phase) of interest (Dalbey et al. 1998; MFWP file reports). We will validate and adjust these earlier findings for use in the Flathead (Bovee 1978, 1986; Nehring 1992; Payne 1988). Mathematical relationships must be based on the best fit between the dependent and independent variables. This can typically be demonstrated graphically, by model component, so that unrealistic results can be identified and corrected. Where results are counter-intuitive, additional samples can be collected to validate (or disprove) previously established relationships.

Study Design

The Flathead River has been stratified into distinct reach breaks based on gradient, inflowing tributaries, and channel morphometry. Reach 1 extends from the confluence with the South Fork Flathead River to a gradient break above the Stillwater River confluence. Reach 2 extends through a low gradient, braided section to the point where the channels rejoin into one channel. Reach 3 is downstream of the braided section and ends at the gradient break where Flathead Lake begins to influence river stage (full pool elevation 2893 ft msl). The segments were further segmented based on channel stability, sinuosity and substrate types. High resolution aerial photography will be used to update a GIS map of the Flathead. Areas of rapid change will be stratified separately. Sampling of fish and zoobenthos will be stratified on season, flow and temperature.

Parameters

The overall goal of this project, dove tailed with 9401002, is to quantify the influence on flow and water temperature on fish seasonal occurrence, movements and species interactions. The two parameters are manageable through dam operation and selective withdrawal thermal control, and are the dominant factors influencing all other parameters under investigation. These include: substrate type, focal velocity as it relates to column velocity, depth and proximity to cover. Zoobenthos will be grossly linked to substate type and channel location. This project will incorporate biological data into a model layer for overlay on the physical framework model.

Analysis

Each of the parameters listed above are habitat categories to be analyzed using Chi Square and MANOVA with canonical analysis. Physical measurements made by this project will quantify the total availability of each habitat category. Two hypotheses are combined below for brevity:

H_o: Habitat availability in each category is proportional to riverine discharge and is proportional to water temperature.

Ha: Habitat availability in each category is not in proportion to riverine discharge or is not proportional to water temperature.

Some details will be decided through negotiation with the successful contractor selected by BPA to complete the Flathead Instream Flow (IFIM) Project (9502500) currently in RFM process

5. Assess seasonal operational strategies: Flathead River species show obvious seasonality in life cycles, migrations and relative abundance. We assume that some periods of the year will be more sensitive than others and that acceptable range of flow fluctuation and rate of change will differ seasonally. To assess this relationship, multiple model simulations will be performed across the range of expected (hydrologically possible) conditions. Results will be used to establish an acceptable range of seasonal operations.

6. Document modeling methodology, analytical results, recommendations and user instructions in a detailed final report. A draft report will be submitted to MFWP, CSKT and experts in the field for peer review. Comments and suggestions will be incorporated in the final report to be published in full by BPA. Professional manuscripts will be developed by agreement between cooperators for submission to refereed journals.

g. Facilities and equipment

See Umbrella Proposal for detaile description of MFWP facilities. The Contractor will provide facilities and equipment as part of their contract. MFWP will supply some minor equipment and support (projects 9101903 and 9401002).

h. Budget

The first two years were approved at $100,000 per year. This proposal pertains to the third year of the project at $100,000. The RFP states that this project must be completed in three years for $300,000. The budget breakdown was intentionally left open so that the selected contractor can allocate funds as needed to complete their contract with BPA. BPA will require a detailed budget breakdown in the contract workplan.

Section 9. Key personnel

Information on Key Personnel form the selected contractor will be compiled during the RFP and selection process.

The MFWP liaison overseeing the execution of this project and coordinating related projects is Brian Marotz (see umbrella for detailed resume). B.S. Biology 1980, M.S. Fisheries Management 1984, Certified Fisheries Scientist AFS 1989, Montana Governor’s Award 1994. Marine, estuarine and freshwater experience. Fisheries Program Officer for MFWP since 1991.

Section 10. Information/technology transfer

The Contractor report will be submitted to MFWP and BPA. Project results will be published in BPA reports and, where applicable, peer reviewed journal articles. Monthly or quarterly reports will be available to all agency and citizen groups.

Congratulations!